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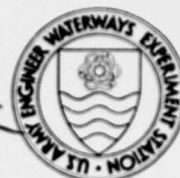
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MISCELLANEOUS PAPER M-77-14

AN EXAMPLE OF APPLYING REMOTE SENSING TO A CORPS OF ENGINEERS ARCHEOLOGICAL PROBLEM

by

Lewis E. Link, Jr.

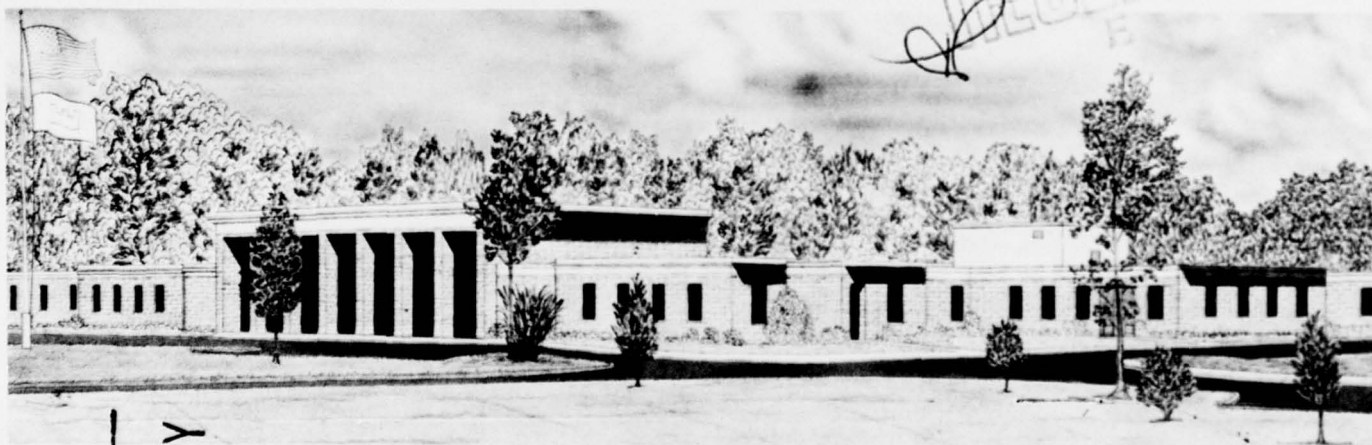
Mobility and Environmental Systems Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

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charts were readily available for an area suspected to be the site of an old French village, Old Kaskaskia, near St. Genevieve, Missouri. The U. S. Army Engineer District, St. Louis, was interested in the site of the village because of a proposed levee improvement project under consideration for the area. The available information and nature of the problem provided an excellent opportunity to demonstrate at low cost the applicability of remote sensing techniques for locating features of archeological significance at military installations and acquire information relevant to an existing Corps district problem. ←

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PREFACE

The study reported herein was conducted by personnel of the U. S. Army Engineer Waterways Experiment Station (WES) from September 1976 through August 1977. The study was conducted under Department of the Army Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities," Task 01, "Environmental Quality Management for Military Facilities," Work Unit 003, "Remote Sensing of the Environment," sponsored by the Directorate of Military Construction, Office, Chief of Engineers, U. S. Army.

The study was conducted under the general supervision of Messrs. W. G. Shockley, Chief, Mobility and Environmental Systems Laboratory, and Mr. B. O. Benn, Chief, Environmental Systems Division. The study was directed by Dr. L. E. Link, Chief, Environmental Research Branch (ERB). The work reported herein was accomplished by Mr. George Schabillion, Agronomist, ERB, and Dr. Link. The report was prepared by Dr. Link. Acknowledgment is made to Mr. Ron Tulcher, Environmental Section, and Mr. Lester Arms, Chief, Mapping Section, U. S. Army Engineer District, St. Louis, Missouri, for their assistance in finding pertinent materials for the study.

Director of the WES during this study was COL J. L. Cannon, CE. Technical Director was Mr. F. R. Brown.

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AN EXAMPLE OF APPLYING REMOTE SENSING TO A
CORPS OF ENGINEERS ARCHEOLOGICAL PROBLEM

PART I: INTRODUCTION

Background

1. Perhaps one of the most effective ways that modern man has to examine the effects of man-caused environmental changes is to study in detail what our forefathers have done to modify the earth and the lasting impacts of those modifications. With rapid urbanization, changes in land use, and new construction activity being common events, it is critical that sources of information concerning past events be preserved whenever possible. This entails location and identification of such things as old settlements and sites of archeological significance before they are inadvertently destroyed. This is particularly important in the case of activities such as major construction or military training which are destructive to the terrain. Our moral obligation to preserve the details of the past has been recognized by Congress, which has enacted legislation to ensure that our history is preserved. The requirements for historic preservation are outlined in Chapter 8 of Army Regulation AR-200-1, C2, Environmental Quality, Environmental Protection and Enhancement. Thus, prior to a major project such as construction of a levee or water impoundment, construction of large buildings at a military post, or changing the land use within a specified area, it is important that an effort be made to survey the areas to be affected to determine whether any sites or features of archeological significance are present.

2. Aerial photography has been used in many cases (both in Europe and the United States) to identify archeological sites. The work in the United States has included discovery of prehistoric roadways in New Mexico, earthwork sites in the Ohio Valley, aboriginal Indian fish traps on the Potomac River, and a Pre-Arikara fortified village site (end of

first millenium A.D.) along the Missouri River. The fortified village site was an especially surprising find since both sides of the Missouri River had been examined intensively by archeologists for a quarter of a century.* The synoptic view afforded by remotely sensed imagery and the increased ability to grasp the significance and relation of terrain features provided by a synoptic perspective can thus result in discovery of features previously unsuspected or overlooked by conventional ground surveys. In addition, if mapping quality sensors are used, the imagery provides a permanent record for later use and an excellent base for mapping.

Purpose and Scope

3. The purpose of this report is to document a study that illustrates the applicability of conventional remote sensor imagery for obtaining archeological information relevant to a Corps of Engineers construction project. The study was intended to exemplify the type of archeological data acquisition problem that might confront facilities managers at military installations as well as Corps district offices.

4. A proposed levee improvement project by the U. S. Army Corps of Engineers District, St. Louis, was planned for an area of Kaskaskia Island, south of St. Genevieve, Missouri. The major concern was that construction of the project might disturb or cover up remnants of a historic French village called Old Kaskaskia. As such, the object of the WES effort was to establish the location of any portion of Old Kaskaskia that still exists.

5. The following paragraphs document the conduct and results of the WES study. The general approach taken was to obtain any available information concerning the configuration of the area when the town of Old Kaskaskia was inhabited. This information was used in conjunction with recent aerial photography to establish the present status of

* Manual of Remote Sensing, American Society of Photogrammetry, Falls Church, Va., 1975

Old Kaskaskia. The study provides a good example of how the basic principles discussed in Appendix A, Remote Sensing of Archeological Features, can be used to obtain valuable information concerning an archeological feature of interest to the Corps.

PART II: DOCUMENTATION OF STUDY

Information on Kaskaskia

6. Information concerning the original and present status of the Old Kaskaskia town site was obtained from the following sources:

- a. U. S. Army Engineer District, St. Louis
- b. Ms. Margret Kimball Brown, Fort de Chartres Historical Site, St. Genevieve, Missouri
- c. Illinois Department of Transportation
- d. Clerk and Recorder of Randolph County, Chester, Illinois
- e. University of Missouri
- f. Missouri School of Mines
- g. Southeast Missouri Regional Planning Commission

7. Inquiries with the above sources resulted in the following information that was used to assist in determining the current status of Old Kaskaskia:

- a. May 1974 aerial photography, approximate scale 1:63,000
- b. February 1973 aerial photography, approximate scale 1:24,000
- c. January 1970 aerial photography, approximate scale 1:12,000
- d. Story of Old St. Genevieve, Gregory M. Franzwa, Patrice Press Inc., St. Louis, Missouri, 1967
- e. Board of Examination and Survey of Mississippi River Chart No. 7, 1908
- f. Mississippi River Commission Chart No. 110, 1880
- g. A 1771 map by "the Hutchins" published in London by Act of Parliament, November 1778.

8. Based on the reference materials obtained, the town of Old Kaskaskia was the site of a long-standing Indian village which in 1673 contained up to 74 cabins. By 1700 it became a center of trade, complete with its own French missionary. By 1719 the town was so crowded that the Indians were ordered out, and they founded a new village about 5 miles* up the Kaskaskia River. In 1809 Old Kaskaskia was the capital

* To convert to metric (SI), multiply miles (U. S. statute) by 1.609344 to obtain kilometres.

of the Illinois Territory and in 1818 it was named the capital of the state of Illinois.

9. The beginning of the end for Old Kaskaskia occurred in the flood of 1881 when the meandering Mississippi River intercepted the Kaskaskia River at a point approximately two miles above the town. The town folk soon abandoned the town site and moved to a safer location where the town of Kaskaskia is currently located.

10. The Mississippi River Commission Chart No. 110 had the best information found on the status of Old Kaskaskia in 1880. Figure 1 shows the pertinent portion of that chart. Examination of the figure shows that Old Kaskaskia was located on the Kaskaskia River a short distance from the Mississippi River which flowed around the west side of what is now known as Kaskaskia Island. The street pattern of Old Kaskaskia is laid out clearly on the chart.

11. The Board of Examination and Survey of Mississippi River Chart No. 7 (1908) showed the status of Old Kaskaskia in the 1908 time frame. Figure 2 shows the pertinent part of that chart. Comparison of the charts in Figures 1 and 2 indicates that a considerable amount of the town site had been captured by the Mississippi by 1908, however, Kaskaskia (Old) is still named on the chart as well as the site of the present day Kaskaskia (New). The existence of a remnant of the town site was at best uncertain.

12. The May 1974 aerial photography provided a synoptic view of the area of interest, see Figure 3. The possible site of Old Kaskaskia and the site of the existing town of Kaskaskia are indicated on the photograph. The May 1974 photographs, at the scale of 1:63,000 did not provide enough detail for the purpose of this study, and they have the disadvantage of the potential alteration of the ground surface by floods that occurred along the Mississippi River during the spring of 1973. The January 1970 aerial photography, with an approximate scale of 1:12,000, was the best information available for depicting the current status of Old Kaskaskia. Figure 4 is a reproduction of a portion of an individual frame of the 1970 aerial photography that shows the potential

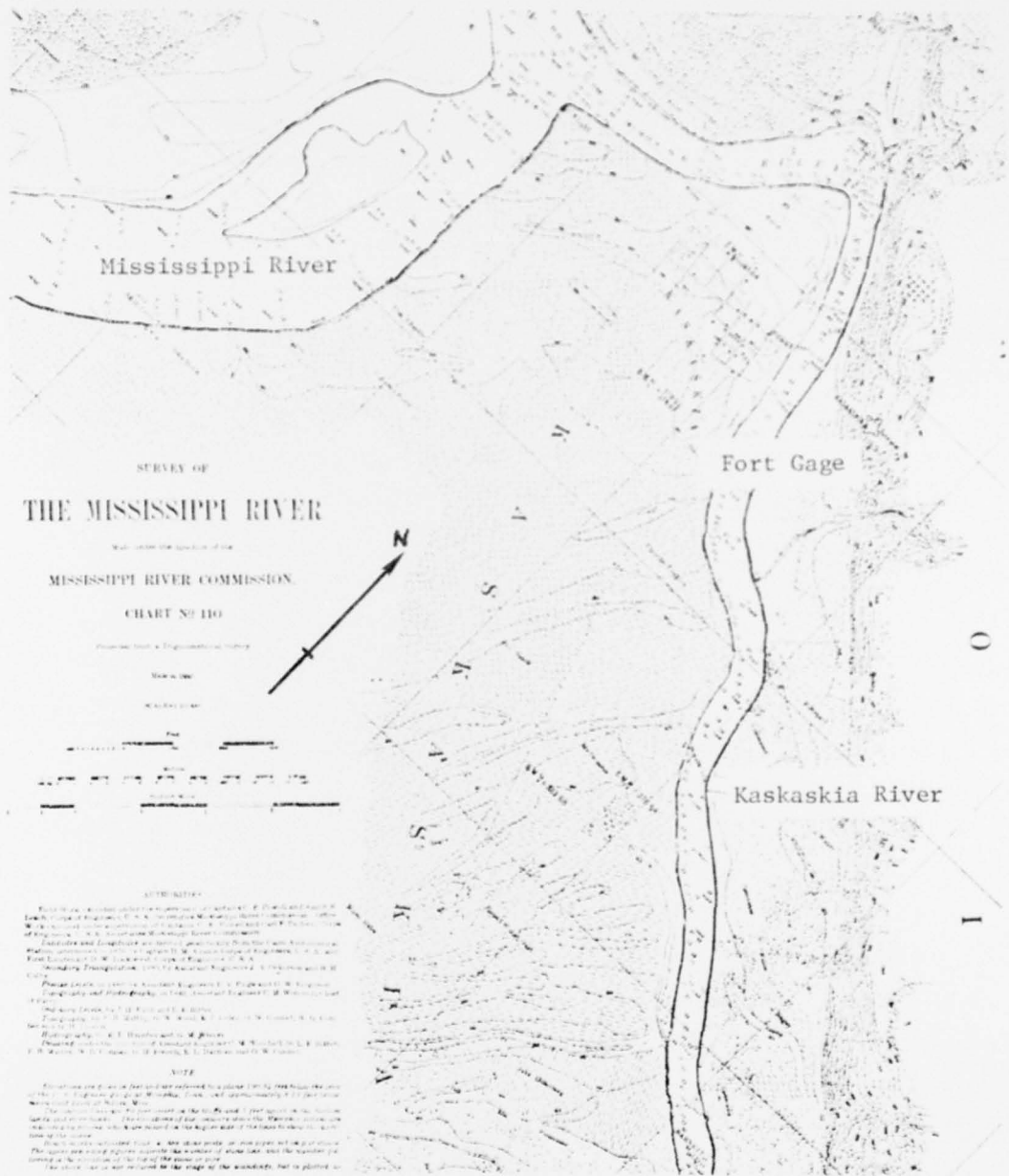


Figure 1. Mississippi River Commission Chart No. 110, 1880, showing town of (Old) Kaskaskia

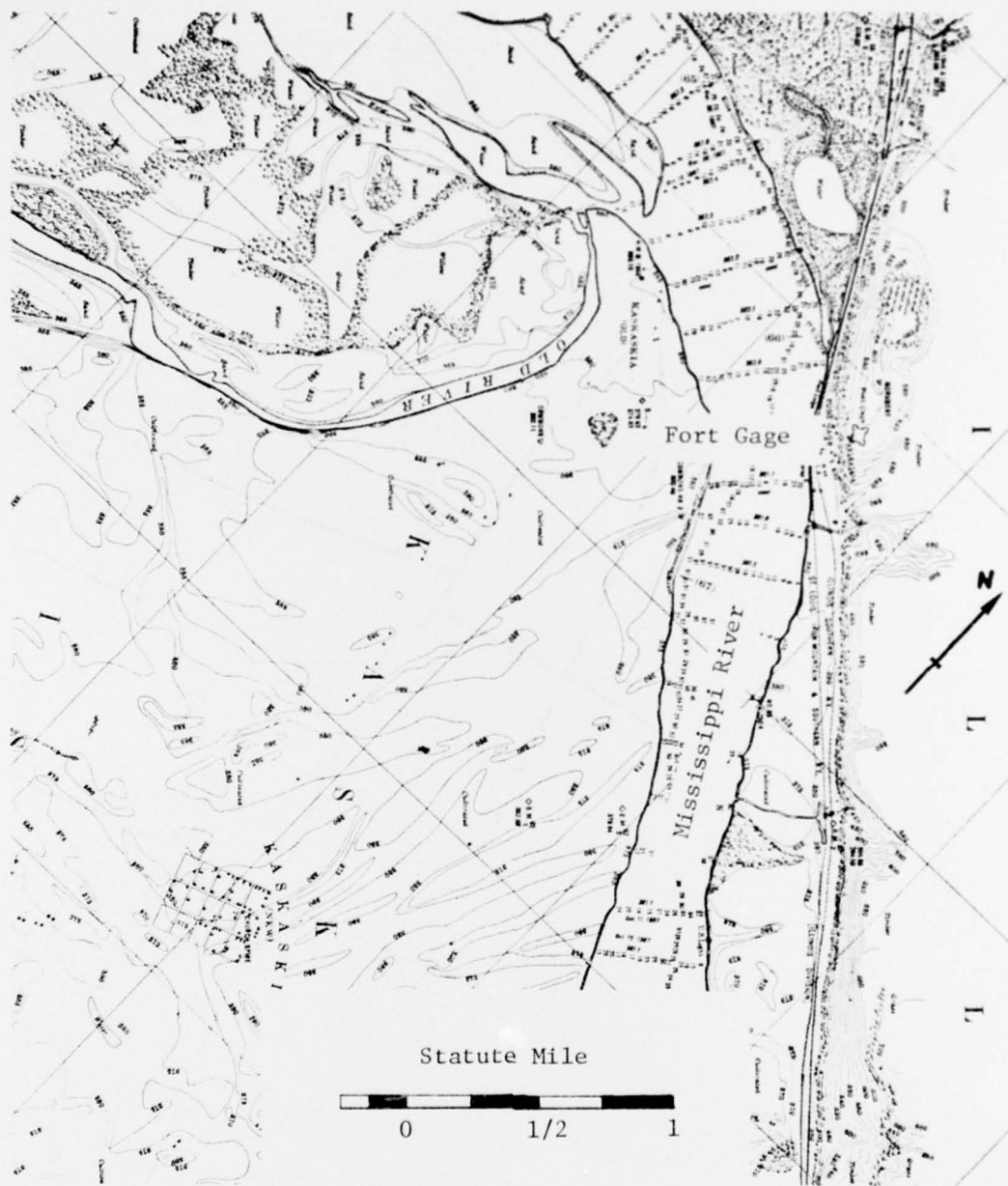


Figure 2. Board of Examination and Survey of Mississippi River
Chart No. 7, 1908, showing (Old) Kaskaskia and
(New) Kaskaskia town sites

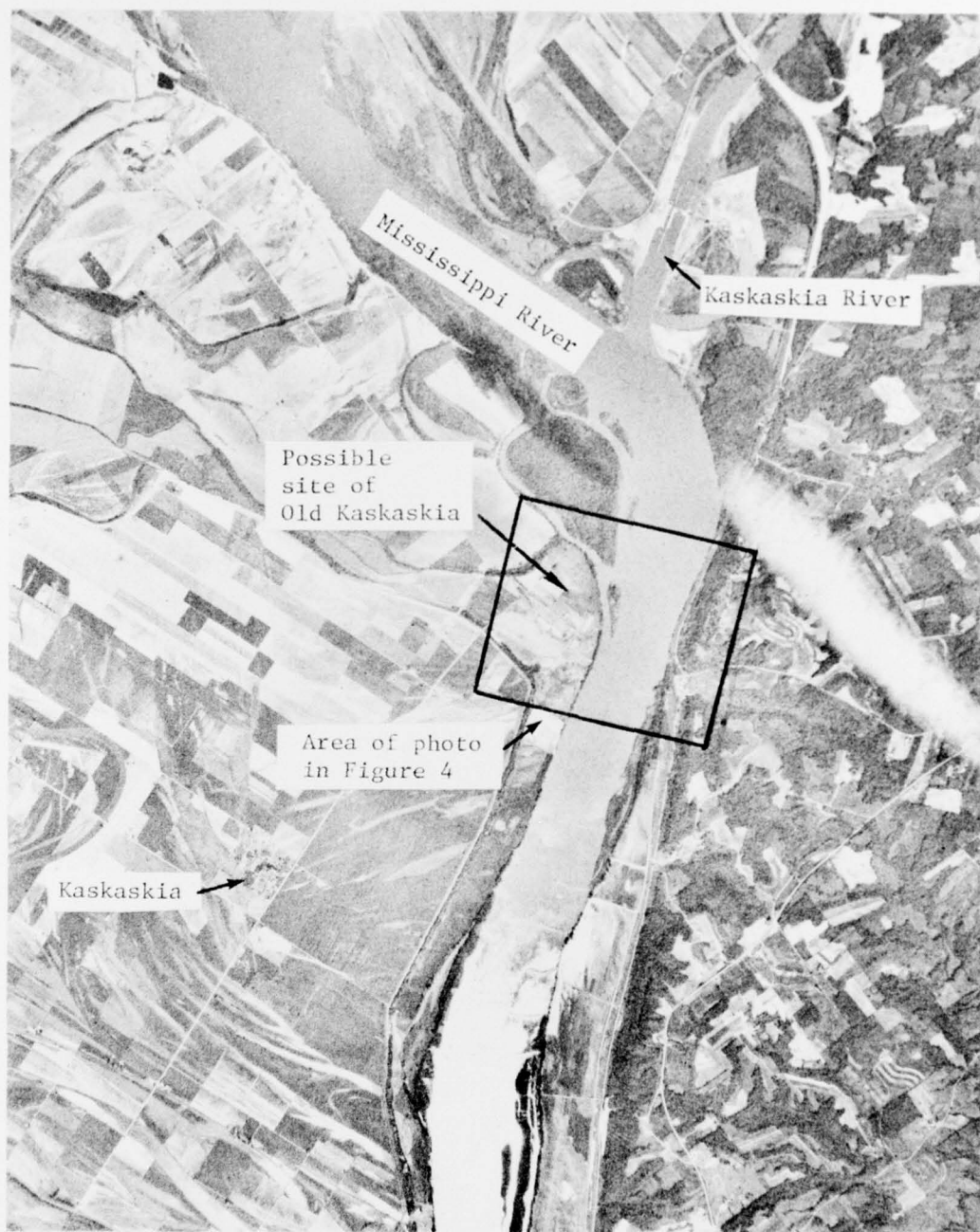


Figure 3. Aerial photograph, scale 1:63,000, showing area of Kaskaskia Island and associated terrain features

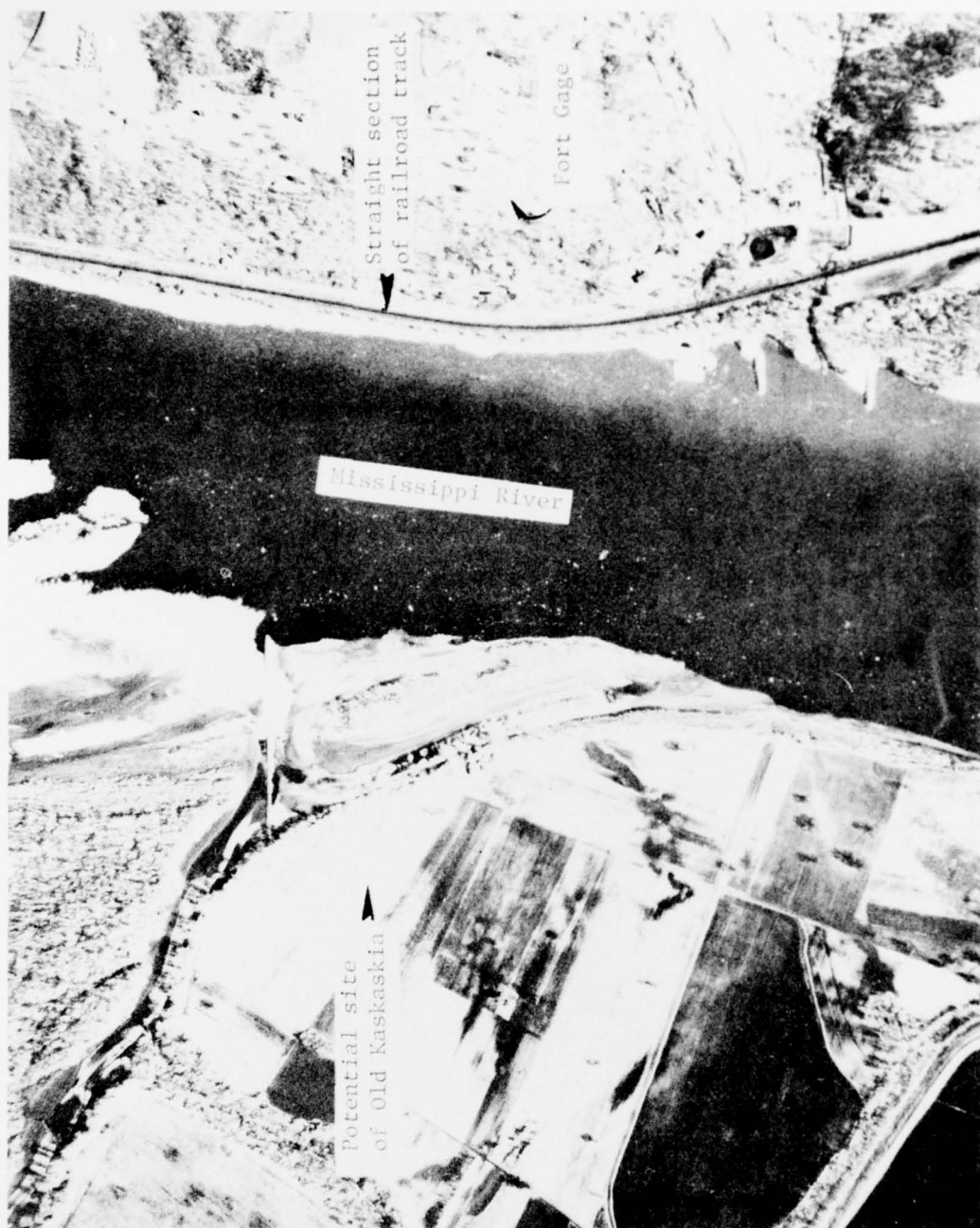


Figure 4. January 1970 aerial photograph of area of Old Kaskaskia, scale 1:12,000

site of Old Kaskaskia. The approximate area shown in Figure 4 is outlined on the photograph in Figure 3.

Status of Old Kaskaskia

13. The 1880 Mississippi River Chart No. 110 was used as a base map since it was assumed to be the most accurate information available on the location of the site of Old Kaskaskia with respect to the surrounding terrain features. The existence or non-existence of a portion of the old town could best be established if the current (1970) river bank boundary could be accurately displayed on the 1880 chart. For the purpose of completeness and to provide an intermediate check, it was decided to plot both the 1908 and 1970 river bank positions on the 1880 chart.

14. Plotting the 1908 and 1970 river boundaries on the 1880 chart could only be accomplished if some common reference point and coordinate system could be established for all three references, the 1880 chart (Figure 1), the 1908 chart (Figure 2), and the 1970 aerial photograph (Figure 4). This required a terrain feature that was evident in 1880 and is still evident on the 1970 photograph. Examination of the charts in Figures 1 and 2 reveals that the outline of an old fort, Fort Gage, is plotted on both charts. The fort is located on the northeast side of the Kaskaskia River directly across the river from Old Kaskaskia on the 1880 chart (Figure 1) and in a similar position (northeast of the Mississippi River) on the 1908 chart. Detection of the remnants or outline of the fort on the 1970 photograph would supply the needed common point.

15. Close examination of Figure 4 shows that the outline of Fort Gage can be detected on the photograph. The fort outline is apparent because of surface relief (see Appendix A). The prior positions of the fort walls have caused a depression and an adjacent small rise in the terrain that has the precise outline of the fort as shown in Figures 1 and 2. It is interesting to note that the imagery used was obtained in January when the trees were free of foliage, giving a relatively unobstructed view of the terrain surface.

16. The location of Fort Gage on the aerial photograph provides the necessary common reference point for plotting the 1908 and 1970 river bank positions on the 1880 chart. It is still necessary to establish a coordinate system common to all three to accurately transfer the information. The charts in Figures 1 and 2 have a common coordinate system, the latitude and longitude lines shown on the charts. It was necessary to establish this coordinate system on the aerial photograph.

17. The 1908 chart and the aerial photograph had a common linear feature, the straight section of railroad track at the base of the bluff on which Fort Gage was located. The orientation of the straight section of railroad track with respect to the lines of latitude on the 1908 chart was used to establish the orientation of lines of latitude on the 1970 aerial photograph. At this point, given that the chart and photo scales are known, all the information needed to establish the 1908 and 1970 boundaries of the Mississippi River on the 1880 chart was available. Establishing the river boundaries for 1908 and 1970 involved measuring the distance from the southernmost corner of Fort Gage to the edge of the river (on the 1908 chart or 1970 photograph) for a range of azimuth angles from west to south at 5-degree increments, and, using the appropriate scale factor, plotting those points on the 1880 chart. Figure 5 shows the 1908 and 1970 Mississippi River boundaries plotted on a simplified 1880 chart.

18. Examination of Figure 5 reveals that the Mississippi River had washed away most of the site of Old Kaskaskia by 1908, and by 1970 it appears that all traces of the town are gone. Further examination of the aerial photographs did not reveal any apparent patterns that would indicate possible remnants of the town site.

Summary

19. This study provided information that will assist in the planning of the St. Louis District levee improvement project. The concern over disturbing or destroying remnants of Old Kaskaskia need not

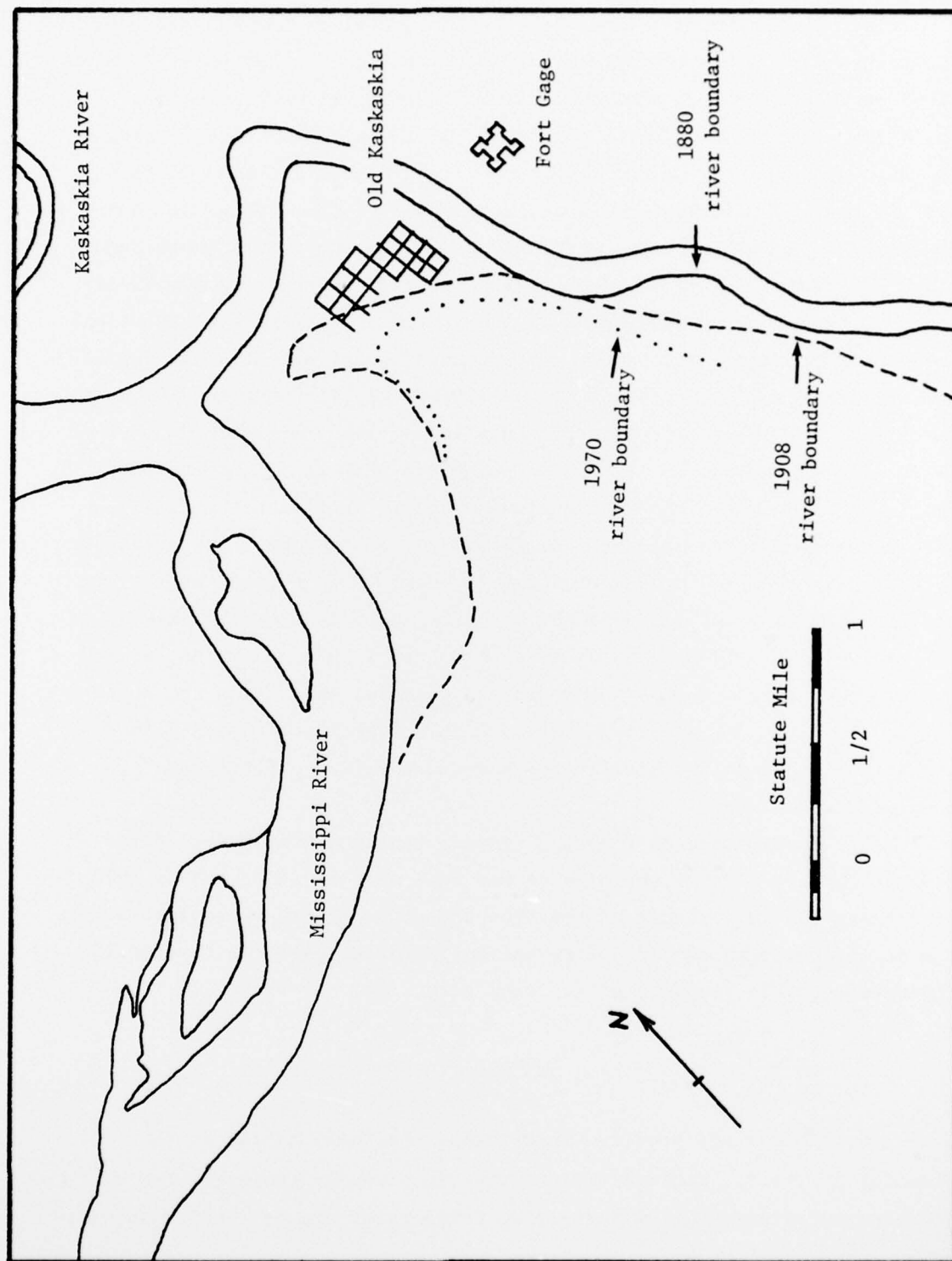


Figure 5. Simplified form of 1880 chart with 1908 and 1970 Mississippi River boundaries plotted

be a deterrent in the execution of that project. On a broader perspective, the study also illustrates how remote sensing imagery can be used to examine an area for suspected features of historical or archeological significance. In many instances, as in this case, new imagery need not be acquired; existing imagery can be used to do the job at a much reduced cost.

APPENDIX A: REMOTE SENSING OF ARCHEOLOGICAL FEATURES

1. Recognition or identification of features of archeological interest must normally rely on indirect clues unless a physical feature or structure exists on the terrain surface. Experience has shown that these "clues" are recognizable shapes or patterns in the tones on a photo image and that for aerial photography a majority of these tonal patterns are due to surface relief, plant marks, and soil marks.* The following paragraphs briefly address these "clues" as well as a few miscellaneous features known to provide information of archeological significance.

2. Surface relief. Anomalies in photo image tones caused by surface relief are usually caused by shadow effects or the influence of the relative orientation of the incident energy and the terrain surface. This "clue" is best observed when imagery is obtained at times of low sun angles. The shadowing effect can result from a regular change in the earth's surface or the surface of a forest canopy.

3. Plant marks. Plant marks are changes in image tones resulting from changes in plant condition or type. The changes in plant condition or type (causing a change in reflectance) can result from man-made disturbances of the soil such as buried walls, pits, foundations, or ditches. The buried unnatural feature can stimulate or inhibit plant growth. In either case an anomalous plant mark can occur.

4. Soil marks. Soil marks are regular patterns of image tones related to changes in soil tone (color), texture, or moisture. They are normally most apparent after a rain and in cultivated fields. Of course, soil marks are of most use in areas with little or no vegetation or at times of the year when cultivated fields are bare of vegetation.

5. Miscellaneous features. Other features (clues) of interest include such things as damp marks, parch marks, and snow marks. Damp marks result from areas of high soil moisture retention (e.g. from a filled channel or ditch). Parch marks result from plant stress during dry periods (e.g. vegetation growing over a buried hard surface may

* Manual of Photographic Interpretation, American Society of Photogrammetry, Falls Church, Va., 1960

wilt before that in adjacent areas). Snow marks result from slight topographical variations and consist of regular patterns created by selective snow melting or accumulation of windblown snow.

6. The clues discussed above relate to aerial photography; however, they may also cause anomalous tonal patterns on thermal infrared (IR) imagery. Any change in surface soil moisture or surface material type may create detectable temperature contrasts at sometime during the diurnal cycle. Soil moisture changes are particularly good sources of temperature anomalies because of the high specific heat of water compared to air (i.e. having water instead of air in the soil voids changes the thermal properties of the soil volume considerably). In addition, small changes in the orientation and magnitude of surface relief change the amount of solar energy absorbed by the material during the day and could create meaningful temperature anomalies during the night. It is yet to be determined just how well archeological features will be portrayed by the thermal anomalies. The basic physics of the phenomena involved suggests that thermal IR imagery may be a very good tool for archeological reconnaissance surveys.

7. In addition to providing possible visual evidence of the existence of an archeological feature, imagery used in conjunction with old charts and historic accounts can provide information about the approximate position of an archeological site. Relating terrain features shown on old charts or described in travel accounts by explorers to features evident on recent imagery can help establish the approximate location of a site whose position is currently unknown or uncertain. This is especially true in dynamic environments such as river floodplains where changes in channel shape and position are common over a number of years or the direct evidence of a site is masked by sediments deposited during recent floods.

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